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Advanced Onsite Wastewater Treatment Systems: A Strategy for Natural Resource Protection

t Bay National Estuarine Research Reserve Science and Policy Bulletin Series

This bulletin stems from the WBNERR 1992 conference on advanced onsite wastewater treatment systems, which explored the potential for using these systems in coastal watersheds, as a component of comprehensive plans, to address existing and projected nitrogen loading problems. While this bulletin reflects the sense of the 1992 WBNERR meeting and the thoughts of some of those most knowledgeable about these systems, debate continues over some of the information we report.*

How Can We Limit Nitrogen Inputs to Coastal Salt Ponds and Bays?

There is no single solution. There are a number of technological and planning tools available to limit the total amount of nitrogen from homes and businesses in a coastal watershed so that it does not cause unacceptable deterioration of the receiving waters. All of the available tools should be used in the context of logical, comprehensive planning.

One historically popular technological option,is sewering and centralized wastewater treatment plants. A second is small, community-based wastewater treatment plants, for either raw wastewater or effluent from conventional septic tanks that travels from the septic tanks through small diameter pipes.

A third and important option is using advanced wastewater treatment systems for the home ("onsite" wastewater treatment systems). These systems treat the wastewater where it is produced, at the home or business - hence the name "onsite" systems - and they discharge to the ground a higher quality effluent than conventional septic tank-leach field technology, which is not adequate to protect groundwater and surface water resources in some areas.

Why Look At Advanced Onsite Wastewater Treatment Systems?

These technologies have a number of advantages. First, compared to building or extending a central sewer system, advanced onsite wastewater treatment systems can be economical. One part of this economic advantage is the ability to match the number of systems to the size of the community. Central plants are generally built to accommodate wastewater flows from projected populations. Since these projections are uncertain, the plants are sometimes larger than necessary; yet the existing waste producers using the plant must pay the entire cost. Other times the community grows faster than expected and outgrows the capacity of the plant. A related issue is that conventional sewering can actually encourage development; the community has an incentive to add houses in order to recoup the cost of the sewer. With advanced onsite wastewater treatment systems, the number of systems installed matches the size of the community and can expand at whatever rate the community grows.

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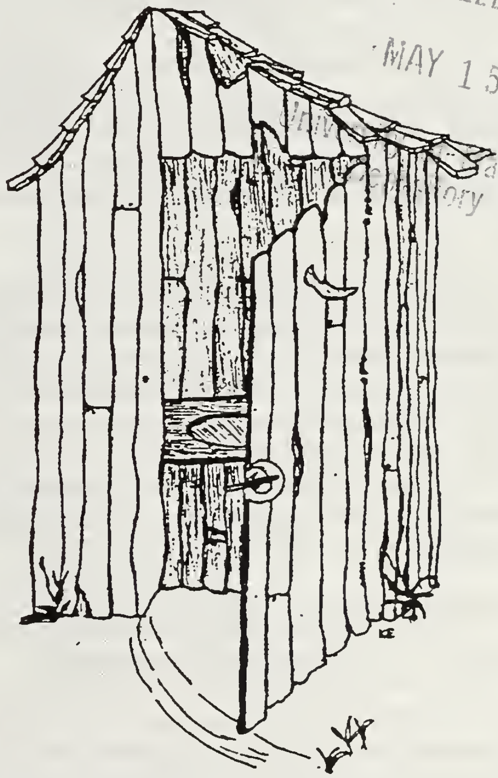

The History of Wastewater: 1400 A.D.
Illustrations by Karen Esswein

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* *For information on why nitrogen is a problem in coastal waters and the importance of septic tanks as a source of nitrogen, contact WBNERR.*

Selected key features of advanced, onsite wastewater treatment systems:

- *Allow for close fit between the strength of waste produced at a particular site and the level of treatment/technology required at the site.*
- *Allow for close fit between supply and demand.*
- *Allow close fit between level of waste treatment and the nature of the resource area where the waste is produced.*
- *Create small business opportunities.*
- *Require oversight of operation and maintenance by a local board or regional agency, sometimes in cooperation with a 3rd party contractor.*
- *Allow tighter clustering of development and therefore greater flexibility in land use planning than traditional septic systems.*
- *Periodic short-term failures will have only minor impacts on the total waste stream discharged to the environment.*
- *Failures are generally inexpensive to repair, at least from a community-wide perspective; systems are designed for easy maintenance.*
- *Because individuals must think about their wastewater, they are more likely to take responsibility for their behaviors in generating waste. This requires a comprehensive education effort.*

A second benefit of advanced onsite wastewater treatment systems is that they can be specialized to treat a variety of types of waste. Compared to centralized collection and treatment systems, which combine wastewater from many sources, advanced onsite wastewater treatment systems treat stronger waste (e.g., from restaurants) separately from other wastewater (e.g., from single family residences). In addition, the cost of treating this high strength waste is borne by its producer, rather than by all other homeowners and businesses in the area.

Third, the necessary maintenance and oversight for advanced onsite wastewater treatment systems presents communities with small business opportunities, as pointed out in a 1992 concept paper by the Association for the Preservation of Cape Cod (APCC). These opportunities range from constructing and installing systems to monitoring and maintaining them throughout their lives. So, much of the money spent for onsite wastewater treatment systems goes back into the local and regional communities.

Can I Actually Use Advanced Onsite Wastewater Treatment Systems?

It depends on the system and on where you live. In Florida, for example, using a sand filter or composter requires only that users obtain approval from the local health department. In Maine, the regulations do not differentiate between peat filters and conventional septic tank - leach fields; both technologies are considered standard. In Washington State, there are two or three thousand intermittent sand filters in use today. Similar stories of the extensive use of alternatives come from California, Maryland, and Oregon.

In Massachusetts, the RUCK system is permitted as an alternative, which requires approval from the local board of health as well as a variance from DEP. To apply for a variance costs $400, and DEP has sixty days to respond to applications. Massachusetts also allows composting systems, as long as they are used in combination with a standard septic tank-leach field. The DEP is also optimistic about its ability to grant speedy variances for sand filters.

Why Don't States Permit More of These Technologies?

Aside from evaluating the technologies, which many states consider the lesser challenge, the main hurdles that regulatory agencies face are ensuring adequate maintenance, oversight, and management of the systems. In some cases, regulatory agencies are further burdened with the legacy of wastewater treatment regulations being used for land use management. Communities and local boards need to work together to create strategies such as wasetwater management districts that will ensure the long-term oversight and maintenance of onsite wastewater treatment systems.

Will Using these Systems Lead to Excessive Development in Our Communities?

Compared to traditional methods advanced onsite wastewater treatment systems may allow for higher housing densities - and the consequent preservation of open space. The result may be tighter clusters of housing without an overall increase in the number of houses in a community. Although land use planning in Massachusetts has been closely tied to the wastewater treatment regulations, this is not desirable from the perspective of a planner or natural resource manager. Housing densities should be based on logical comprehensive planning stemming from a community's vision of what it wants to be and where it wants to grow.

Nitrogen loading is only one of a myriad of factors that need to be considered in planning for land use. Of equal importance are other natural resource constraints (e.g., wetlands, plant and wildlife habitat, flood hazard areas), as well as the availability of public infrastructure, the need for affordable housing, the location of economic centers, and historic land use and settlement patterns. The key point is that nitrogen loading is not and should not be the sole basis for determining desirable land use patterns.

In Massachusetts, What is My Part in Getting There?

As a Homeowner:

- ▲ *Educate yourself about nitrogen loading and advanced onsite wastewater treatment systems. Reading this document is a great start!*
- ▲ *Consider installing an advanced onsite system at your home, either as a retrofit to your old system, or as a new system, especially if your existing system needs to be replaced.*
- ▲ *Attend meetings of your local board of health, and encourage them to consider using these systems as part of a comprehensive planning effort by the town.*
- ▲ *Properly maintain whatever onsite wastewater treatment system you currently own. This will demonstrate that individual homeowners can and should take responsibility for maintaining conventional and advanced onsite wastewater treatment systems.*

As a Small Business Owner:

- ▲ *Consider installing an advanced system at your business.*
- ▲ *Consider what business opportunities the widespread use of advanced onsite wastewater treatment systems might present for you, and work with local and regional planning and health agencies to expand your business.*

As a Representative on the Board of Health:

The Massachusetts DEP feels that, considering the potentially large number of systems involved, their permitting, surveillance, and enforcement capabilities would be overwhelmed. Therefore, the Department states that it would have to rely on local boards of health (although DEP recognizes that these local boards are also often understaffed) or on local wastewater management districts for management and oversight.

Board members and health agents should:

- ▲ *Determine which geographic areas within your jurisdiction are critical resource areas, in order to prioritize areas for the use of advanced onsite wastewater treatment systems. Areas likely to receive high priority include wellhead protection areas and shallow, enclosed bays. Marine embayments that do not exhibit signs of eutrophication still require the board's attention.*
- ▲ *Work with neighboring towns to establish a coordinated plan for protecting critical resource areas. Often, the land area that drains to a coastal water body falls within the jurisdiction of more than one town.*
- ▲ *Establish and implement programs for inspection and maintenance of existing systems.*
- ▲ *Document locations of sub-standard systems and force upgrades to advanced systems.*
- ▲ *Learn about systems that currently exist which would meet your established performance criteria.*
- ▲ *Write a proposal to DEP for installing and managing new systems; convince DEP that you are serious about management and oversight, that you want to work with them, and that you have a good plan.*
- ▲ *Further inform yourself about this issue. Reading the more detailed WBNERR report from the conference is a good start.*

As a Conservation Agent:

Educate yourself further regarding new technology and how that technology relates to conservation. Then, working with the Boards of Health, educate the public; encourage homeowners to use systems appropriate for each site. Act as a regulatory check point with other local environmental agencies to be sure that installed systems are adequately monitored.

As a Planning Board Member:

Consider using advanced onsite wastewater treatment systems as a tool to achieve comprehensive planning goals and to move beyond planning constraints posed by traditional wastewater treatment options.

Anticipate how zoning and development procedures might change in response to the increased availability of these systems. Work closely with other local boards, which will undoubtedly receive requests for variances.

As a Selectman:

- ▲ *Pass bylaws to delineate environmentally sensitive areas.*
- ▲ *Require performance standards in environmentally sensitive areas.*
- ▲ *Establish funding sources for inspection and maintenance programs for onsite wastewater treatment systems.*
- ▲ *Create annual awards for organizations that implement outstanding programs about onsite wastewater treatment.*

As a Legislator:

- ■ *Draft and support legislation which will help fund the research and implementation of innovative wastewater treatment systems.*
- ■ *Commission task forces to perform the necessary economic and technical analyses.*

Where Do We Go From Here? A Report From the Conference Working Groups

We need to **establish comprehensive educational programs about wastewater treatment** options. These programs should address towns, vendors, municipal boards, researchers, system users, and state, regional, and federal agencies. We need to educate as many people as possible that:

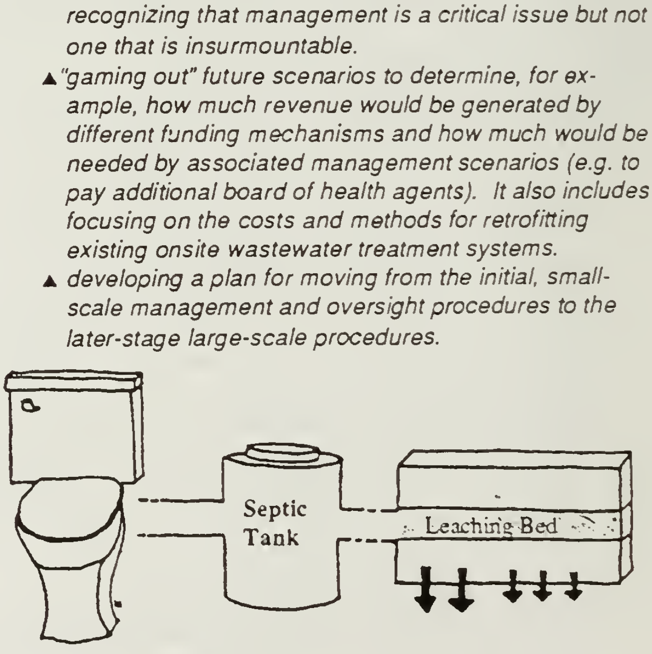
- ☐ *The myth that conventional septic systems are adequate to protect public health and the environment in all situations is just that - a myth. In much of southeastern Massachusetts the high nitrogen concentrations in the effluent contribute to degradation of groundwater and estuaries.*
- ☐ *Nitrogen loading to groundwater impacts both human health and estuarine ecosystem structure and function.*
- ☐ *Wastewater treatment standards may need to be higher in recharge areas to coastal waters than in other areas.*
- ☐ *Advanced onsite wastewater treatment systems are viable tools to use as part of the solution, and decentralized wastewater treatment systems can have significant environmental and economic advantages over large centralized systems.*

We need to **create a regulatory climate that fosters innovation,** that asks for a better mouse trap. This could include actions by the state of Massachusetts such as:

- ○ *Incorporating knowledge about nutrient loading into state wastewater treatment codes.*
- ○ *Promulgating legislation like the Wisconsin Groundwater Law (requires drinking water quality effluent) and the Pennsylvania Clean Streams Law.*
- ○ *Fostering cooperative agreements between state agencies to construct and monitor demonstration sites.*
- ○ *Establishing grant programs like the Wisconsin Fund for replacing failed systems with innovative systems.*
- ○ *Removing regulatory and bureaucratic barriers to innovation (e.g. excessive permitting requirements and filing fees for variances for innovative technologies) while retaining regulations necessary to protect the environment and public health.*
- ○ *Making a commitment to actively support communities that establish reasonable maintenance and oversight programs.*
- ○ *Drafting model procedures to enable third party maintenance of advanced onsite wastewater treatment systems.*
- ○ *Reducing siting restrictions for systems that produce high quality effluent.*
- ○ *Implementing clear and reasonable performance standards.*
- ○ *Establishing a date by which existing systems in areas where a higher level of treatment is needed would have to be replaced by advanced systems.*
- ○ *Taxing the use of conventional technology.*
- ○ *Enabling towns to apply for revolving loans, garnered and administered by the state, to fund advanced onsite wastewater treatment systems.*
- ○ *Deciding upon events that will trigger an enforced upgrade requirement.*
- ○ *Establishing databases that allow comparisons of technologies, associated costs, and environmental benefits.*
- ○ *Following Wisconsin and Washington in implementing a performance based regulatory code that would allow flexibility and long-range comprehensive planning.*
- ○ *Assembling case studies/models of management of advanced onsite wastewater treatment systems.*
- ○ *Requiring operating permits for all onsite wastewater treatment systems, with associated inspections and fees. The fees could be directed to a special fund for appropriate disbursement.*
- ○ *Establishing a process for the effective and timely evaluation, operation, and management of new systems.*

We need to **develop an approach for phasing in the use of advanced onsite wastewater treatment systems.** This means:

- ▲ *prioritizing areas for using these systems.*
- ▲ *determining how they will be managed when there are only a few in the ground and when, in the future, there are hundreds or thousands of them in the ground. This means determining the tasks that need to be accomplished and identifying agencies appropriate for each task. It means anticipating future needs (e.g., establishment of public-private partnerships, implementation of mandatory pumping schedules). It also means recognizing that management is a critical issue but not one that is insurmountable.*
- ▲ *"gaming out" future scenarios to determine, for example, how much revenue would be generated by different funding mechanisms and how much would be needed by associated management scenarios (e.g. to pay additional board of health agents). It also includes focusing on the costs and methods for retrofitting existing onsite wastewater treatment systems.*
- ▲ *developing a plan for moving from the initial, small-scale management and oversight procedures to the later-stage large-scale procedures.*



The History of Wastewater: 1970 A.D.

Which Communities Use These Systems to Protect Their Natural and Cultural Resources?

Three communities taking the initiative and using advanced onsite wastewater treatment systems to improve wastewater treatment from existing development are Washington Island, Wisconsin; Thurston County, Washington; and Gloucester, Massachusetts.

A group of citizens representing over twenty civic associations in the watershed of Waquoit Bay, Massachusetts has been working with the Citizens for the Protection of Waquoit Bay, the Association for the Preservation of Cape Cod, and the Waquoit Bay National Estuarine Research Reserve to draft an action plan for the watershed in order to protect and restore the natural resources of the bay. The action plan includes promoting the use of nitrogen-removal onsite wastewater treatment systems in the watershed and designating the watershed a demonstration area for these systems.

*What Are Nitrogen Removal Onsite Systems and What Technologies Are Available?**

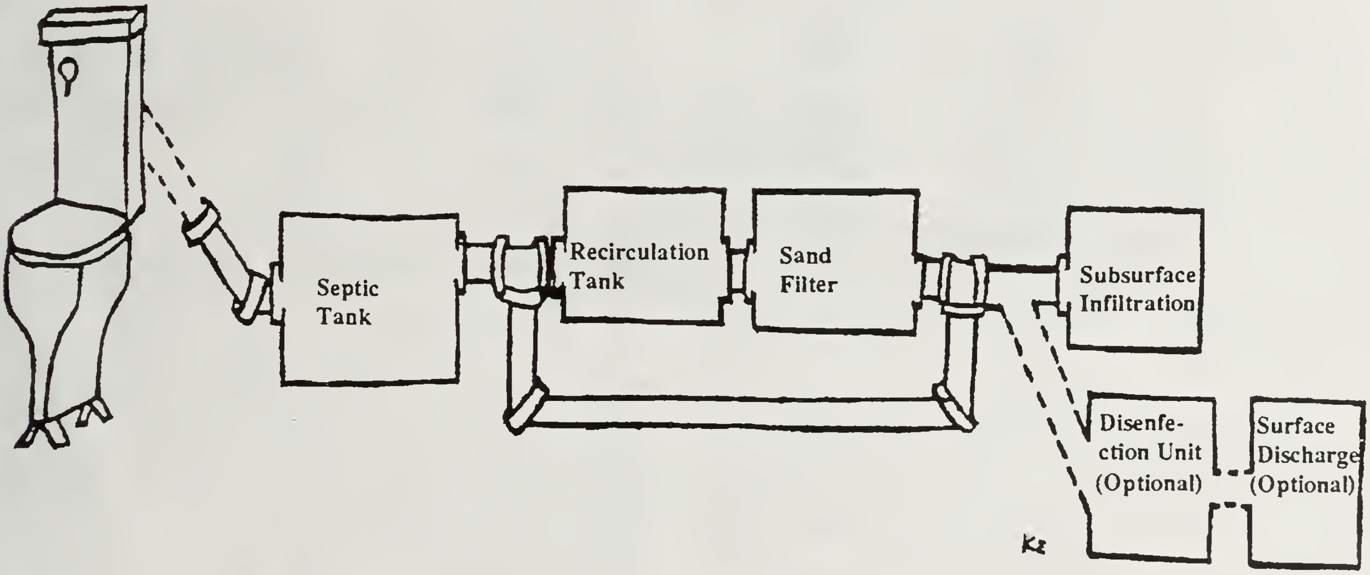
Background

Nitrogen removal onsite wastewater treatment systems remove much of the nitrogen from wastewater and exist on the site that they service. There are three strategies which systems employ to achieve this goal: 1) Convert the nitrogen in wastewater into nitrogen gas (in this form it is innocuous since the Earth's atmosphere is 80% nitrogen). To accomplish this process (called nitrification/denitrification) requires passing the wastewater through a sequence of aerated and oxygen-free environments, in which the bacteria that convert the various forms of nitrogen are active. 2) Use micro-filters or resins to attract and remove ionized nitrogenous waste. This entails cleaning, or regenerating, the filter media periodically, much as household water purifiers are cleaned. The resulting nitrogen-rich liquid could then be denitrified or recycled as fertilizer. 3) Intercept the bulk of nitrogen-rich waste (i.e. toilet and kitchen wastes - "black water") and compost it or store it for off-site treatment.

In discussing "nitrogen removal", it is clearly important to consider not only how the nitrogen is removed from the wastewater but also where the nitrogen ultimately goes. Converting it to nitrogen gas solves the groundwater and surface water problems but is energy-inefficient because considerable energy is expended converting nitrogen gas to nitrate for chemical fertilizer. Recycling a nitrate-rich liquid or compost as fertilizer is more efficient in this regard. The third option, carting the nitrogen-rich wastewater off-site adds trucking costs and associated environmental impacts; of course, wastewater treatment must follow the storage and transport. The transport option also reinforces the prevalent perception that wastes can just disappear, which may not encourage environmentally responsible pollution prevention practices by individuals.

Sand Filters and Synthetic Media Filters

These systems pass the septic tank effluent across filters made of sand or alternative material (e.g. pea gravel, ash, mine slag, synthetic media). This process creates an oxygen-rich environment where bacteria convert ammonium in the effluent to nitrate. This liquid then enters an oxygen-free environment, where bacteria convert nitrate to nitrogen gas, which escapes to the atmosphere.



The History of Wastewater Treatment: 1990 A.D.

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* *For design specification for advanced on-site systems, see WBNERR information sheets from the February, 1992 Nitrogen Removal Conference.*

Nitrogen removal rates vary from 50% to over 95% depending upon the particular system. More complex systems tend to achieve higher removal rates but also have a higher cost and more extensive maintenance requirements.

These filters have the added advantage of capturing solids that are carried out of the septic tank. This both reduces the strength of the waste and prolongs the life of the leach field.

One variation on this type of system is the RUCK system, which incorporates a layered sand filter and which separates the black and grey water.

Composting Systems and Holding Tanks.

Separating black and grey water can be an attractive option because black water contains 60-90% of the nitrogen in all domestic wastewater but can account for less than 15% of the total flow. Thus, it is possible to provide nitrogen removal facilities for a small portion of the waste stream and remove a lot of the total nitrogen.

Of these systems, some store the black water in a holding tank. Others compost it, with either a dry system or one incorporating a flush toilet. The compost or ash that results from these systems is commonly added to soils at the site. Incineration toilets evaporate and burn toilet wastes leaving an ash which is disposed with the household trash. The gray water waste generally flows through a conventional septic tank and leach field, but this system can also include a denitrification component like a sand filter or peat filter.

Mechanically, these systems are relatively simple and therefore are unlikely to break down. In addition to treating the nitrogen, they greatly reduce the volume of solids. Although this is not directly connected to the nitrogen pollution problem, it is closely tied to the problems of solid waste disposal and septage treatment.

Peat Filter

All of the effluent from the septic tank runs through a peat bed, which serves as both filter and leach field. Monitoring systems in Maine suggests that removal rates can exceed 90% of the total nitrogen in the wasewater. In addition, these systems seem to require extremely minimal maintenance.

Related concerns include the excavation of peat, an essentially non-renewable resource, and the transportation of peat to distant sites.

For more Information:
Call Waquoit Bay National Estuarine Research Reserve • (508) 457-0495, National Small Flows Clearinghouse • (800) 624-8301
See WBNERR White Paper on Nitrogen Removal Systems & WBNERR Information Sheets from the Conference.

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